

On the mechanism of reaction diffusion in the systems Cu-Se, Cu-Te, Ag-Se and Ag-Te. 126-2-8/35

There are 5 references, 2 of which are Slavic.

SUBMITTED: December 28, 1956.

ASSOCIATION: Ural State University imeni A. M. Gor'kiy.  
(Ural'skiy Gosudarstvennyy Universitet imeni A.M.Gor'kogo).

AVAILABLE: Library of Congress.

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Arkharov, V. I.

126-2-9/35

AUTHORS: Arkharov, V. I., Mar'yevich, V.P., Reynkhol'd, M., and Simonova, M. I.

TITLE: On the texture of iron scale. (O teksture v zheleznoy okaline). XI. Investigation of the scale forming during oxidation of iron in  $\text{CO}_2$ . (XI Issledovaniye okaliny, obrazuyushchetsya pri okislenii zheleza v uglekislom gaze).

PERIODICAL: Fizika Metallov i Metallovedeniye, 1957, Vol.5, No.2, pp. 251-254 (USSR)

ABSTRACT: The dissociation pressure of  $\text{CO}_2$  in the temperature range of about  $1000^\circ\text{C}$  brings about equilibrium conditions for the existence of  $\text{Fe}_3\text{O}_4$  in the same way as for  $\text{H}_2\text{O}$ . If iron is oxidized in water vapour, scale is formed, the external layer of which consists of magnetite with certain structural anomalies distinguishing it from the equilibrium  $\text{Fe}_3\text{O}_4$  (Refs. 2,3). For obtaining detailed information on the mechanism of oxidation of iron, it was of interest to investigate the scale forming on iron in a  $\text{CO}_2$  atmosphere and to compare the structural picture with that obtained for the case of oxidation in water vapour. Three series of tests were made with a constant gas speed and a temperature of about  $1000^\circ\text{C}$  with armco iron specimens in the form of cylinders of 6 mm dia. and

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On the texture of iron scale. X I. Investigation of the scale forming during oxidation of iron in  $\text{CO}_2$ . 126-2-9/35

30 mm length annealed for durations of 3, 7 and 14 hours. By means of X-ray investigations it was established that during the initial stage (about seven hours) the oxidation of the iron at  $1000^\circ\text{C}$  in a  $\text{CO}_2$  atmosphere produces a scale of the phase  $\text{FeO}$  and no signs of the presence of  $\text{Fe}_3\text{O}_4$  on the outside surface of the scale could be detected. This is attributed to the fact that the speed of supply of oxygen to the reaction front is limited. In the subsequent stage the process is limited by the continuously decreasing speed of supply of iron to the reaction front and, as a result of that, conditions occur which are favourable for forming an  $\text{Fe}_3\text{O}_4$  layer above the  $\text{FeO}$  layer. Following that, the structural picture of the process of oxidation in a  $\text{CO}_2$  atmosphere is similar to that pertaining in  $\text{H}_2\text{O}$  vapours. The difference occurring in the initial stages in these two cases is attributed to differences in the adsorption and desorption of gaseous components. There is one table and 6 references, 5 of which are Slavic.

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SUBMITTED: February 12, 1957.

ASSOCIATION: Institute of Metal Physics, Ural Branch of the Ac.Sc.USSR.  
(Institut Fiziki Metallov Ural'skogo Filiala AN SSSR)

AVAILABLE: Library of Congress.

126-2-24/35

Autoradiographic investigation of the influence of small additions of antimony on the diffusion of silver in polycrystalline copper.

diffusion zone of silver and copper during etching of cuts, the observed differences in the diffusion character of silver into pure copper and into copper with 0.4% Sb was attributed to differing etching properties of the solid solutions of copper-silver and copper-antimony-silver. For verifying the earlier obtained results autoradiographic studies were made of the diffusion of silver into copper and into a copper alloy containing 0.4% Sb. Prior to diffusion annealing the specimens were subjected to treatment identical with that described in the earlier work (Ref.1), namely, forging followed by annealing at 900°C for 5 to 6 hours. Under standardized conditions Ag<sup>110</sup> was deposited in vacuum on the surface of the specimens. Diffusion annealing was effected in vacuum for fifty hours at 650°C. After annealing, the specimens were ground parallel to the active surface. Thus, in contrast to earlier work of one of the authors (Ref.1), cross sections of the diffusion zone were investigated which are perpendicular to the direction of the diffusion. The thickness of the removed layer was measured with an accuracy up to  $\pm 0.002$  mm. Figs.1 and 2

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Autoradiographic investigation of the influence of small additions of antimony on the diffusion of silver in polycrystalline copper.

show the autoradiograms of cross sections at equal depth from the active surface (0.1 mm). It can be seen that in the pure copper there are "sections" of projections of the diffusion front along the grain boundary which were not revealed by microstructural methods in the earlier work (Ref.1). However, in the alloy containing 0.4% Sb the "sections" of such projections are considerably more pronounced. If in the copper the silver is revealed on the investigated cross sections of the cut only along certain boundaries, the distribution of active silver in the alloy completely surrounds the grain boundaries. This result confirms fully the qualitative observations made in the earlier work (Ref.1). Fig.1 shows the diffusion of  $Ag^{110}$  into pure copper at  $650^{\circ}C$  for a duration of fifty hours, a depth of cut of 0.1 mm; magnification 20 times, exposure 150 hours. Fig.2 shows the diffusion of  $Ag^{110}$  into a copper alloy containing 0.4% Sb as a result of annealing at  $650^{\circ}C$  for fifty hours; depth of cut 0.1 mm, exposure time 150 hours, magnification 20 times.

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126-5-3-17/31  
AUTHORS: Arkharov, V. I., Berenova, I. P. and Magat, L. M.

TITLE: On Accelerating the Ageing of Alloys of Aluminium with Magnesium Under the Influence of Small Admixtures of Silver and Zinc (Ob uskorenii protsessa stareniya splavov alyuminiya s magniyem pod vliyaniyem malykh primesey serebra i tsinka)  
(On the causes of the Influences of Small Admixtures on the Kinetics of Ageing of Alloys III) (K voprosu o prichinakh vliyaniy malykh primesey na kinetiku stareniya splavov. III)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1957, Vol 5, Nr 3, pp 516-526 (USSR)

ABSTRACT: Ageing of the alloys is subjected to the influence of admixtures. The selection of admixtures is generally based on empirical data. For a scientifically justified approach to this problem it is necessary to study the mechanism of the influence of the admixtures on the decomposition of saturated solid solutions. There is reason to assume that this mechanism is complicated. In absence of a sufficiently strong change in the solubility, the influence of admixtures on ageing may be

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On Accelerating the Ageing of Alloys of Aluminium with Magnesium  
Under the Influence of Small Admixtures of Silver and Zinc.  
(On the Causes of the Influences of Small Admixtures on the  
Kinetics of Ageing of Alloys III)

due to internal adsorption. In earlier work (Refs.1-3), this problem was investigated on alloys of the solid solution type of copper in aluminium with admixtures of zinc or silver and conclusions were derived on the horophilic nature of these admixtures relative to aluminium base solid solutions and on the adsorptional nature of the influence on the decomposition of saturated solid solutions of copper in aluminium. Conclusions on the horophilic nature of admixtures of zinc and Ag relative to Al were also derived in later work of the authors (Ref.4). For investigating further this problem, alloys of the binary system Al-Mg were chosen. This system is the basis of numerous important ageing engineering alloys. As admixtures Zn and Ag were taken for which it is possible to assume that they are horophilic relative to the aluminium solvent. In earlier work (Ref.5) it was found that small admixtures of zinc have an accelerating influence on the ageing of

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On Accelerating the Ageing of Alloys of Aluminium with Magnesium  
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Kinetics of Ageing of Alloys III)

Al-Mg alloys. The chemical compositions of the alloys used in the experiments are entered in tables, p.517. In Fig.1 the changes are graphed of the parameter of the crystal lattice of a solid solution as a function of time for an ageing temperature of 250°C; Fig.2 gives similar graphs for an ageing temperature of 300°C. In Fig.3 the dependence is graphed of the parameter of the crystal lattice of a solid solution on the concentration of the alloys. Table 5 gives the values of the lattice parameter of the phase T and of the solid solution at 300°C. The graphs Figs.6-9 contain the results of additional investigations of ageing in the systems Al-Mg-Ag and Al-Mg-Zn-Ag. By means of the method of measuring the changes in the lattice parameter of a decomposing solid solution with ageing time, it was established that admixtures of 0.2 to 1.0% zinc and silver accelerate the ageing of Al-Mg alloys. Analysis of experimental data on the solubility of Mg in Al in presence of zinc

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On Accelerating the Ageing of Alloys of Aluminium with Magnesium  
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Kinetics of Ageing of Alloys III)

admixtures and also analysis of literary data on the diagram of state of the ternary system Al-Mg-Zn indicates that the observed acceleration in ageing cannot be attributed to the intensification of the total saturation of the solid solution with Mg in presence of a small admixture of zinc (it increases altogether only by 0.2 to 0.3% Mg). Apparently, this acceleration is due to a large extent to internal adsorption of zinc on the periphery of transient formations in the decomposing solid solution and also on the periphery of separating out crystallites of the excess phase. The influence of silver admixtures is similar. In judging the mechanism of the influence of small admixtures of a third component on the kinetics of decomposition of a saturated binary solid solution, it is necessary to take into consideration the character of the isotherms and of the conodes on the diagram of state of the respective ternary system. Thereby, the solubility value is important which corresponds

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On Accelerating the Ageing of Alloys of Aluminium with Magnesium  
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Kinetics of Ageing of Alloys III)

to the intersection of the conode passing through the point of the composition of the alloy with the isotherm delimiting the phase region which encloses the composition of the alloy, and not the solubility which corresponds to the intersection of the straight line passing through the point of the composition of the ternary alloy parallel to the side of the concentration triangle. If this isotherm is intersected from the side of the concentration triangle at an acute angle and has a large length, then even a small admixture may bring about appreciable change of the saturation of the solid solution. If the angle of the intersection of the isotherm from the side of the triangle is large and the length of the isotherm is small, even a large admixture will have little influence on the saturation of an ageing alloy. In this second case a change of the kinetics of ageing under the influence of Card 5/6 admixtures can be due to the effect of internal adsorption.

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On Accelerating the Ageing of Alloys of Aluminium with Magnesium  
Under the Influence of Small Admixtures of Silver and Zinc.  
(On the Causes of the Influences of Small Admixtures on the  
Kinetics of Ageing of Alloys III)

There are 9 figures, 5 tables and 13 references, 7 of  
which are Soviet, 3 English, 3 German.

ASSOCIATIONS: Ural'skiy gosudarstvennyy universitet imeni  
A. M. Gor'kogo (Ural State University imeni A.M. Gor'kiy)  
Sverdlovskiy filial VNIIM (Sverdlovsk Branch of VNIIM)

SUBMITTED: July 17, 1957

1. Aluminum-magnesium alloys--Aging    2. Silver--Metallurgical effects  
3. Zinc--Metallurgical effects

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ARKHAROV, V.I.

Ways for increasing the level of research in plant laboratories. Zav.  
lab. 23 no.3:259-262 '57. (MIRA 10:6)  
(Metallurgical laboratories) (Research)

*ARKHAROV, V. I.*  
USSR/Physical Chemistry / Thermodynamics, Thermochemistry, B-8  
Equilibria, Physical-Chemical Analysis, Phase Transitions.

Abs Jour : Referat Zhur - Khimiya, No 1, 1958, 387

Author : V.I. Arkharov, D.K. Bulychev.

Inst : Academy of Sciences of USSR.

Title : Influence of High Pressure on Dissociation of Ferrous Oxide.

Orig Pub : Dokl. AN SSSR, 1957, 113, No 4, 791-794

Abstract : The influence of high pressure on the dissociation of vyustit\*) (I) below the treble equilibrium point (575° for pure FeO) was investigated. I with a lattice parameter of 4.2940 Å served as the initial material. The dissociation of I, which had been compressed first by the---  
\*) [The translator could not find out what "vyustit" is and what is its name in English.]

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ARKHAROV, V.I.

20-2-16/60

AUTHORS: Arkharov, V. I. , Borisov, B. S.

TITLE: On the Problem of the Oxidation Mechanism of Magnetite  
(K voprosu o mekhanizme okisleniya magnetita)

PERIODICAL: Doklady Akademii Nauk SSSR, 1957, Vol. 114, Nr. 2, pp. 293-296  
(USSR)

ABSTRACT: At first the present state of the problems is described and reference is made to earlier papers dealing with the same subject. The facts mentioned in this connection show that the crystallochemical mechanism of the reaction  $M \rightleftharpoons G$  requires further detailed definition. For this purpose the authors made experiments on the oxidation of natural magnetite-monocrystals on the air at various temperatures and a structural analysis of the oxidation-products. The radiographic and the electronographic methods were employed in the analysis. The natural (octahedral) surface of the magnetite-crystal in the initial state and the surface layer of the magnetite crystal after its oxidation at temperatures of more than 800°C were radiographically investigated by the authors.

Card 1/3      The results of the superficial oxidation of the natural sur-

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On the Problem of the Oxidation Mechanism of Magnetite

face of the outer octahedral surfaces. Then the oxygen-atoms diffuse into the lattice and cause its reconstruction. There are 3 figures, and 13 references, 8 of which are Soviet.

ASSOCIATION: Institute for the Physics of Metals of the Ural Branch AS  
USSR  
(Institut fiziki metallov Ural'skogo filiala Akademii nauk  
SSSR)

PRESENTED: July 9, 1956, by G. V. Kurdyumov, Academician

SUBMITTED: July 5, 1956

AVAILABLE: Library of Congress

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ARKHAROV, V.I.

18(7)

PHASE I BOOK EXPLOITATION

SOV/1340

Akademiya nauk SSSR. Ural'skiy filial. Institut fiziki metallov

Voprosy teorii zharoprochnosti metallicheskih splavov (Problems in the Theory of Heat Resistance of Metal Alloys) Moscow, Izd-vo AN SSSR, 1958. 160 p. (Series: Its: Trudy, vyp. 19) 3,500 copies printed.

Eds.: Arkharov, V.I. and Sadovskiy, V.D.; Ed. of Publishing House: Rzheshnikov, V.S.; Tech. Ed.: Novichkova, N.D.

PURPOSE: This book is intended for specialists in the field of physical metallurgy.

COVERAGE: (Abstract of Article 1) The articles in this book constitute reports on extensive studies, conducted between 1949 and 1954 by the Institute of Physical Metallurgy at the Urals Branch of the Academy of Sciences, USSR, and devoted to the development of a general theory of heat resistance. A strong need was felt for such a theory because of insufficient knowledge of the physical mechanism of deformation

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too small to be detected by analysis, may considerably change the heat resistance of the alloy, in varying degrees, depending on the heat treatment. It may be concluded that the main factor determining the heat resistance of a crystal is the interatomic bonds in the lattice, which bonds change according to the composition of the solid solution. The first stage of the investigations has been completed and forms the subject matter of the present collection of papers. Results indicate that the basic assumptions have been verified to a considerable extent. These two phenomena, as related to such heterogeneities as transcrystallite joining in polycrystalline alloys (under specified conditions of deformation) have proved to be of decisive importance and can be used as the basis of a hypothesis on how heat resistance is affected by the localization of deformation and by internal adsorption of addition agents in the vicinity of the more minute structural heterogeneities, i.e., the elements of subcrystallite structure (further work is indicated in this direction). Article 2 of the collection gives an

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extensive treatment of the basis of attack on the problem of heat resistance as investigated at the Institute, together with a detailed discussion of the guiding principle underlying all aspects of the study. Articles 3 and 4 attempt to explain the high adsorbability of small additions of a number of elements (e.g., Mo, W, Nb, Ti, Al, B) in iron-chrome-nickel austenite. Article 4 is concerned specifically with the diffusional mobility of one of the main components of the alloy (nickel) in transcrystallite transition zones, an important characteristic as regards heat resistance, inasmuch as plastic deformation at high temperatures [apparently] proceeds by a diffusion-type mechanism. Confirmation of this hypothesis was obtained by analysis of experimental data on high-temperature stress relaxation. This analysis is the subject of Article 10, whereas Article 9 is directly concerned with experimental work on the measurement of stress relaxation. The correlation between data on the transcrystallite diffusional mobility of nickel and on stress relaxation in the investigated alloys is.

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given in Article 11. Article 8 describes methods of measuring high-temperature stress relaxation. Article 5 gives experimental data on the effect of small additions of elements of high internal adsorbability on creep in solid solutions. In this study it is shown that under conditions of low stresses, when the deformation is markedly localized in the transcrystallite transition zones, the adsorption-prone addition agent exhibits a strengthening effect. With high stresses, when the deformation is mainly of the slip type and is distributed throughout the crystallite, internal adsorption of the addition element ceases, but in certain cases of high stress the addition element may lower the resistance of the material to flow. Additional data on this question are given in Articles 6 and 14. Article 7 presents the results of an attempt at experimental microinterferometric confirmation of the occurrence of changes in the distribution of strain in the grain of metal containing small amounts of addition agents. The first small additions produce a marked effect on the deformation, which (with low stresses) is

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Problems in the Theory of Heat Resistance of Metal Alloys SOV/1340

localized at the intercrystallite boundaries; the alloy is strengthened. An increase in the amount of the addition agents results in a coarsening of the crystallites, which increase the rate of flow. These results also agree with the basic hypothesis concerning the effect of internal adsorption on heat resistance and supplement the hypothesis with indications of the range of strain conditions under which the adsorption phenomenon plays a significant role. In the course of investigating stress relaxation, an unusual effect was observed in certain alloys, namely "negative relaxation", consisting in the growth of stresses with time, instead of the usual natural decrease. This effect has been explained by assuming that under the conditions of the relaxation test a phase transformation takes place in the material, resulting in a lowering of the specific volume (discussed in Article 12). This effect received further confirmation in the study reported in Article 13. In Article 16 the author examines the possibility of extending the basic idea of these investigations to subcrystallite structural heterogeneities, especially to those which arise and develop in aging. Since the majority of heat-resistant alloys undergo aging, the internal-adsorption phenomenon becomes a problem of great importance.

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ARKHAROV, V.I.; KLOTSMAN, S.M.; TIMOFEYEV, A.N.; RUSAKOV, I.I.

Study of intercrystalline diffusion in metals and alloys. Issl. po  
sharopr. splav. 3:113-118 ' 58. (MIRA 11:11)  
(Diffusion) (Crystal lattices)



ARKHAROV, V.I.; PEN'TINA, A.A.

Investigating the effect of mutual orientation of crystallites on  
the intercrystalline diffusion and internal adsorption. Issl. po  
sharopr. splav. 3:119-139 '58. (MIRA 11:11)  
(Metal crystals) (Diffusion)

ARKHAROV, V.I.; GALISHEV, V.S.; KLOTSMAN, S.M.; TIMOFYEV, A.N.

Feasibility of autoradiographic detection of nonuniform concentrations  
of adsorption origin. Issl. po sharopr. splav. 3:296-302 ' 58.

(Alloys--Metallography) (Adsorption)

(MIRA 11:11)

ARKHAROV, V.I.; KONEV, V.N.; TRAKHTENBERG, I.Sh.; SHUMILINA, S.V.

Role of nitrogen in the process of high temperature oxidation of  
chromium in contact with air. Issl. po zharopr. splay. 3:402-407  
' 58. (MIRA 11:11)

(Chromium) (Nitrogen) (Oxidation)

ARKHAROV, V.I.; KONEV, V.N.; MEN'SHIKOV, A.Z.

Investigating reaction diffusion in the chromium - nitrogen system.  
Issl. po zharopr. splav. 3:408-414 ' 58. (MIRA 11:11)  
(Chromium) (Nitrogen) (Diffusion)

AUTHORS: Arkharov, V.I., Klotsman, S.M., Timofeyev, A.H. 89-1-1 /13

TITLE: The Employment of Radioactive Tracers When Solving Problems of Internal Adsorption in Solids (Primeneniye radioaktivnykh indikatorov k resheniyu problemy vnutrenney adsorbtsii v tverdykh telakh)

PERIODICAL: Atonnaya Energiya, 1958, Vol. 4, Nr 4, pp. 380-381 (USSR)

ABSTRACT: One of the most important factors influencing the physical properties of technical materials is the influence exercised by the internal adsorption of impurities upon various structural inhomogeneities.  
For a system Cu + Ag with slight Sb-impurities it was found by metallographic as well as by autoradiographic means that with a diffusion of Ag a non-uniform front with projections is formed, which extends far into the intercrystalline boundary. Furthermore, the fact was established by means of Ag<sup>110</sup> that there is a linear dependence between  $\ln i$  (characteristic of volume diffusion) and  $y$  (depth of penetration of the diffusion). It follows therefrom that the Sb-admixtures bring about an essential

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The Employment of Radioactive Tracers When Solving  
Problems of Internal Adsorption in Solids

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change of the diffusion permeability of the intercrystalline zone, which is indicative of the effect produced by the internal diffusion of the admixture. There are 16 references, 14 of which are Soviet.

SUBMITTED: January 9, 1958

1. Copper-silver systems--Adsorptive properties
2. Copper-silver systems--Autoradiography
3. Antimony--Adsorption
4. Silver isotopes (Radioactive)--Applications

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SOV/126-6-1-10/33

AUTHORS: Arkharov, V. I. and Shangareyev, F. L.

TITLE: An X-ray Study of the Recrystallisation of Electrolytic Chromium by the Method of "Thin" Primary Beam  
(Rentgenograficheskoye issledovaniye rekrystallizatsii elektroliticheskogo khroma metodom tonkogo pervichnogo puchka)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 1, pp 82-88 (USSR)

ABSTRACT: Experiments have been carried out in order to increase the accuracy of earlier work on the determination of the temperature at which noticeable recrystallisation of electrolytic chromium deposited under different conditions begins. This has been done by the use of the "thin" primary beam method. In the case of "mat" deposits ( $t = 20^\circ$ ;  $t$  = temperature of the electrolyte) the recrystallisation temperature was found to be  $900^\circ\text{C}$ . For "shining" deposits ( $t = 50$ ) the recrystallisation temperature is considerably lower than the early data indicated, namely, it is now thought to be about  $600-660^\circ\text{C}$  (instead of the early value of  $900-1000$ ). In the case of "milky" deposits ( $t = 80^\circ\text{C}$ ) and deposits obtained at

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An X-ray Study of the Recrystallisation of Electrolytic Chromium  
by the Method of "Thin" Primary Beam

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$t = 44^{\circ}\text{C}$  recrystallisation begins at 800 and  $700^{\circ}\text{C}$  respectively. The dependence of  $t_{\text{recr}}$  on the current density in the region  $D_k = 30-50$  amp/sq. inch has been investigated. An increase in  $D_k$  leads to a decrease in  $t_{\text{recr}}$  by  $50-100^{\circ}\text{C}$ . The dependence of  $t_{\text{recr}}$  on  $t$  and  $D_k$  is correlated with the dependence of the perfection of texture, durability and hardness on these two parameters. The experimental results are interpreted in terms of the theories developed in Refs. 2, 3 and 12. The factor which appears to be decisive is the phase self-hardening which is a result of the change-over from initially hexagonal phase into normally cubic chromium. The experiments were carried out on deposits 30-100 micron thick obtained from electrolytes which consisted of 150 g of  $\text{CrO}_3$  and 1.5 g of  $\text{H}_2\text{SO}_4$  per litre of distilled water.

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An X-ray Study of the Recrystallisation of Electrolytic Chromium  
by the Method of "Thin" Primary Beam

SOV/126-6-1-10/33

There are 3 figures, 3 tables and 13 references,  
8 of which are Soviet, 3 German, 2 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics, Ural Branch of the Ac.Sc.,  
USSR)

SUBMITTED: July 17, 1957

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- |                                  |                              |
|----------------------------------|------------------------------|
| 1. Chromium--Electrodeposition   | 2. Chromium--Crystallization |
| 3. Chromium--Temperature factors | 4. Chromium--X-ray analysis  |

AUTHORS: Arkharov, V. I. and Shangareyev, F. L. SOV/126-6-1-25/33

TITLE: An Investigation of Recrystallisation of Pure Copper Using a "Thin" Primary X-ray Beam (Issledovaniya rekristallizatsii chistoy medi metodom tonkogo pervichnogo puchka rentgenovskikh luchey)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 1, pp 172-173 (USSR)

ABSTRACT: It is shown in Ref.1 that recrystallisation of electrolytic chromium may be detected using a "thin" X-ray beam even in cases where the "thick" beam method yields a negative result (Ref.2). In the present paper the recrystallisation of copper is investigated. As a result of X-ray studies on 99.99% pure copper it was established that:

1. Recrystallisation begins at lower temperatures than was suggested in previous work (Refs.3-8). With prolonged tempering recrystallisation may begin at temperatures as low as 100°C.
2. The "thin" beam method may be successfully used in the detection of the early stages of recrystallisation.
3. The onset of recrystallisation cannot be connected with

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SOV/126-6-1-25/33  
An Investigation of Recrystallisation of Pure Copper Using a "Thin"  
Primary X-ray Beam

any definite temperature. The temperature at which recrystallisation begins depends on the duration of the tempering process and the method whereby recrystallisation is detected. In particular, in the X-ray method the transverse dimensions of the primary beam should be taken into account.

There are 2 tables and 9 references, 8 of which are Soviet and 1 is a Russian translation from English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics, Ural Branch of the Ac.Sc.USSR)

SUBMITTED: July 17, 1957

Card 2/2

1. Copper--Crystallization
2. Copper--Temperature factors
3. X-rays--Applications

AUTHORS: Arkharov, V. I. and Bulychiev, D. K. SOV/126-6-1-31/33  
TITLE: ~~On the Influence of High Pressure on Wustite~~  
(K voprosu o vliyanii vysokogo davleniya na vyustit)  
PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 1,  
pp 186-188 (USSR)  
ABSTRACT: In an earlier work (Ref.1) the author showed that  
decomposition of wustite at temperatures below 570°C  
under high pressures proceeds slower than at normal  
pressure. According to results of experiments at  
normal pressure, 570°C represents the lower limit of  
stability of wustite. In the case of oxidation of  
metallic iron in air at normal pressure at this tempera-  
ture, wustite does not form. For understanding the  
mechanism of the influence of high pressure on the  
decomposition of wustite, it is important to elucidate  
whether the temperature boundary of the stability of  
wustite changes with pressure or whether the influence  
is solely due to the change in the kinetics of the  
process. This problem is also of great interest from  
the point of view of developing a theory of high  
temperature oxidation of iron and steel and the theory  
of reduction of iron oxides. For elucidating this

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On the Influence of High Pressure on Wustite SOV/126-6-1-31/33

problem the authors carried out experiments on oxidation of Armco-type iron in air at pressures of 50 and 100 atm in a specially designed chamber housing a small electric furnace which was screened from the chamber walls. The chamber had an air volume of 500 cm<sup>3</sup> and was so designed that natural convection was ensured. The results of the investigations lead to the following conclusions:

1. At a pressure of 50 atm wustite forms in the scale during oxidation of iron in air at temperatures below 570°C, approximately up to 450°C; at 440°C (50 atm) wustite was no longer observed.
2. A "high temperature" type texture, reflecting intensified diffusion through the scale to the surface is observed in the external layer of the iron scale oxidised at normal pressure in the temperature range where wustite obviously forms; an equal texture is observed below 570°C at a pressure of 50 atm and this appears to confirm the fact that in this temperature range wustite forms in the scale.
3. The formation of wustite in the scale appears to be a necessary factor for a considerable intensification

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On the Influence of High Pressure on Wustite SOV/126-6-1-31/33

of the diffusion of metal to the outside during oxidation and, consequently, an acceleration of this process brings about effects at a high pressure in the temperature range below  $570^{\circ}\text{C}$ , the mechanism of which is basically the same as that of oxidation of iron under normal pressure at temperatures considerably exceeding  $570^{\circ}\text{C}$ . This manifests itself in a considerable intensification of the oxidation of the iron at a high air pressure at equal temperatures leading to a considerable increase of the weight increment of the specimens.

4. Assuming that in the carried out investigations there was no local increase inside the scale and that the temperature measured by the thermocouple corresponds to the temperature of the inside layer of the scale, it can be concluded that an increase of the external pressure to 50-100 atm displaces the lower temperature boundary of the stability of wustite downwards from  $570^{\circ}\text{C}$  to the range of  $450-400^{\circ}\text{C}$ .

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On the Influence of High Pressure on Wustite SOV/126-6-1-31/33

There are 3 figures and 7 references, 6 of which are Soviet, 1 French.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics, Ural Branch of the Ac.Sc., USSR)

SUBMITTED: June 22, 1957

Card 4/4    1. Metallic salts--Analysis    2. High pressure research--  
Test results    3. Iron--Oxidation    4. Metals--Diffusion

SOV/126-6-2-8/34

AUTHORS: Arkharov, V. I., Klotsman, S. M. and Timofeyev, A. N.

TITLE: ~~The Effects of Traces of Impurities on the Diffusion~~  
Coefficients for Polycrystalline Materials (O vliyani  
malykh primesey na koeffitsienty diffuzii v poli-  
kristallicheskikh materialakh). II

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 2,  
pp 255-260 (USSR)

ABSTRACT: Al-110 is used to study the diffusion of silver in pure  
copper, and in copper containing 0.1% Be without and  
with previous heat treatment (100 hours at 863° C, or the  
same plus 50 hours at 590° C). Figs. 1-4 represent the  
results for these cases, in the above order (radiation  
intensity in layer-by-layer electrolytic etching vs. depth),  
in all cases for 100 hours' diffusion at 590° C. The  
effect of the Be is to increase intercrystallite  
diffusion, and the magnitude depends on the treatment.  
The extent to which the Be tends to concentrate in the  
zones between crystallites is discussed in a rather

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SOV/126-6-2-8/34

The Effects of Traces of Impurities on the Diffusion Coefficients  
for Polycrystalline Materials II

general way in the light of the results.

There are 5 figures, 1 table and 13 references, 10 of  
which are Soviet, 3 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics, Ural Branch of the Ac.Sc.,  
USSR)

SUBMITTED: August 21, 1957

Card 2/2    1. Copper alloys--Diffusion    2. Silver--Properties  
             3. Beryllium--Properties

SOV/126-6-3-8/32

AUTHORS: Arkharov, V. I., Simonova, M. I. and Yut, M. K.

TITLE: On the Texture of Iron Scale (O teksture v zheleznoy okaline). XII. Structural Changes in Scale in the Case of Substitution of Atmospheres Producing Higher Oxides by an Atmosphere Producing Wustite (XII. Strukturnyye izmeneniya v okaline pri zamene atmosfer, sozdayushchikh vysshiye okisly, atmosferoy, sozdayushchey vyxstit)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 3, pp 444-449 (USSR)

ABSTRACT: In earlier work the authors investigated the structural changes in scale taking place during high temperature oxidation when substituting the water vapour atmosphere by air (Ref 1) and the air by water vapour, a mixture of water vapour and hydrogen or with pure hydrogen (Ref 2). Such investigations are of interest since they permit elucidation of certain details of the structural picture of the transformations in the system Fe-O representing a particular example of reactions in the solid state. The practical interest of such investigations is due to the necessity of elucidating the influence on gas corrosion of changes in the atmosphere which frequently take place

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On the Texture of Iron Scale. XII. Structural Changes in Scale  
in the Case of Substitution of Atmospheres Producing Higher Oxides  
by an Atmosphere Producing Wustite

under real conditions of operation. The aim of this paper was to investigate by X-rays the changes in the structure of the iron scale, forming in atmospheres which are in equilibrium for the higher oxides of iron  $\text{Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$  (air and water vapour respectively), assuming that the oxidation is continued in the medium with a lower partial pressure of oxygen which is in equilibrium for the lower oxide of iron,  $\text{FeO}$ , i.e. a sufficiently diluted mixture of water vapour and hydrogen. The investigations were carried out on Armco type iron. The method of preparing the oxidation atmospheres, the specimens and the execution of the experiments was similar to that described in earlier work (Refs.2 and 3). Preliminary simultaneous oxidation of the specimens (massive and tubular) was effected in an atmosphere of water vapour for obtaining a magnetite scale in the outside layer, or in air for obtaining hematite in the outside layer. The internal layer of the scale consisted of wustite in all the cases under consideration.

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SOV/126-6-3-8/32

On the Texture of Iron Scale. XII. Structural Changes in Scale in the Case of Substitution of Atmospheres Producing Higher Oxides by an Atmosphere Producing Wustite

Furthermore, pairs of specimens were heated in an atmosphere of a mixture of water vapour with hydrogen at 1000°C; one of these (the tubular one) consisted only of scale, the other had metal under the layer of scale. The holding times of the specimens, which were oxidized preliminarily in air, were 5, 10, 30 and 120 mins. In this part of the experiment (oxidation in a mixture of  $H_2O + H_2$ ) a reference specimen consisting of non-oxidized iron was placed in the furnace for the purpose of verifying the conditions of oxidation, i.e. the composition of the atmosphere; on all the reference specimens a single phase wustite scale formed. Investigation of the structure of the scale, which formed during the preliminary as well as during the subsequent oxidation, included making the X-ray exposures of the external layer with K-Mo radiation for the purpose of detection and analysis of the texture by means of a method (Ref 4) described in earlier work, qualitative evaluation of the relative grain size in the outside

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SOV/126-6-3-8/32

On the Texture of Iron Scale. XII. Structural Changes in Scale in the Case of Substitution of Atmospheres Producing Higher Oxides by an Atmosphere Producing Wustite

layer of the scale on the basis of the "pointedness" of the diffraction lines on the "texturo-graphs" (recorded without rotating the specimens) and also phase analysis of pulverised scale by means of K-Fe radiation. On the basis of the obtained results the following conclusions are arrived at: The scale which forms during oxidation of iron in water vapour or air suffers a number of structural changes if the atmosphere in which it forms is substituted by a mixture of water vapour and hydrogen for which a lower iron oxide, wustite, is in a state of equilibrium at the temperatures 800-1000°C; these changes are attributed to the following processes:

1) On the outside of the scale a process of reduction of the higher oxide into FeO takes place, which is accompanied by the diffusion of iron ions into the depth of the scale; the product of reduction is linked in its orientation with the initial higher oxide from which it inherits the texture. Due to the diffusion of the iron from the external layer to the inside, the reduction

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SOV/126-6-3-8/32  
On the Texture of Iron Scale. XII. Structural Changes in Scale  
in the Case of Substitution of Atmospheres Producing High Oxides  
by an Atmosphere Producing Wustite

propagates to the depth of the scale.

2) The volume changes taking place during the transformation of the lattice of the higher oxide into the lattice of the lower oxide bring about stresses in the outside layer of the scale. This leads on the one hand to formation of cracks (which are particularly intensive in the case that the preliminary oxidation was in air and the scale in the outside layer contained hematite so that during the subsequent stage a double-phase transformation hematite-magnetite-wustite occurs). On the other hand the stresses bring about a recrystallisation which leads to a coarsening of the grain in the layer of the reduced oxide, maintaining the texture, which in this stage will be the texture of the recrystallisation growth. As regards the crystallographic type, it is linked in orientation with the texture which forms directly after the reduction.

3) Crack formation in the outside layer of the scale accelerates reduction in the deeper layers due to the penetration into these of the reducing gas along the cracks

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On the Texture of Iron Scale. XII. Structural Changes in Scale  
in the Case of Substitution of Atmospheres Producing High Oxides  
by an Atmosphere Producing Wustite

and due to its direct interaction with the oxides in the deeper layers of the scale.

4) If there is non-oxidised metal under the scale, the process of reduction of the higher oxide will take place as a result of diffusion of iron from the transforming external layers of the scale as well as as a result of diffusion from the non-oxidised core. This latter process will continue even after completion of the reduction of the higher oxides. At this stage the growth of wustite on the outer side of the scale will increase, whereby the texture which occurs in the preceding stage of the process remains conserved.

5) Conservation in the layer of the wustite of the texture type, which is due to the orientational connection with the original higher oxide, is in agreement (in spite of the non-correspondence of this type with conditions of

Card 6/7 continuing oxidation) with earlier obtained results and

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On the Texture of Iron Scale. XII. Structural Changes in Scale in the Case of Substitution of Atmospheres Producing High Oxides by an Atmosphere Producing Wustite

is apparently due to the small difference in the surface energy of the wustite faces (100), (110) and (111).

There are 7 references, all of which are Soviet.

ASSOCIATIONS: Ural'skiy gosudarstvennyy universitet imeni A. M. Gor'kogo (Ural State University imeni A. M. Gor'kiy) and Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch, Ac.Sc., USSR)

SUBMITTED: December 6, 1957

1. Iron--Scale
2. Iron oxide--Structural analysis
3. X-ray analysis--Applications

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SOV/126-6-4-9/34

AUTHOR: Arkharov, V.I., Belenkova, M.M.,  
Mikheyev, M.N., Moiseyev, A.I. and Polikarpova, I.P.

TITLE: The Effect of Small Additions of Antimony and Beryllium  
on Ageing of the Copper-Silver Alloys (Part IV. On the  
Problem of Causes of the Effects of Small Alloying  
Additions on the Kinetics of Ageing of Alloys)  
(O vliyani malykh primesey sur'my i berillya na  
stareniye splavov med' - serebro (k voprosu o  
prichinakh vliyaniya malykh primesey na kinetiku  
stareniya splavov. IV))

PERIODICAL: Fizika metallov i metallovedeniye, 1958, Vol 6,  
Nr 4, pp 633-642 (USSR)

ABSTRACT: In his previous work (Ref.1-3) the result of which  
indicated that small additions of heterophilic elements  
(elements showing preference for the grain boundaries)  
present in a supersaturated solid solution could affect  
the kinetics of its decomposition by the mechanism of  
adsorption enrichment of the structurally distorted  
zones linking the nuclei of decomposition with the solid  
solution matrix, Arkharov studied the effects of single

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SOV/126-6-4-9/34

The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

additions. The object of the present investigation was to study the simultaneous effect of two homophilic additions. The experimental alloys whose detailed chemical analysis is given in a table on p 633, contained 6% Ag with 0.2 - 0.5% Sb and 0.02 - 0.3% Be added either separately or jointly. The alloys were melted in a H.F. induction furnace, in a graphite crucible with borax used as the covering flux. The cast ingots were heated under charcoal to 800°C, held at the temperature for 2 hrs and cooled in the furnace. They were then rolled to strip 5 mm thick which, after a homogenising treatment consisting of 50 hours at 800°C was used for the preparation of the experimental test pieces. The process of ageing was studied by measuring the variation of hardness, magnetic susceptibility and electrical resistance. The measurements of Rockwell hardness were taken at

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SOV/126-6-4-9/34

The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys (Part 1V. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

15-30 minute intervals on specimens solution treated at 780 - 790°C and aged at 370°C. Magnetic susceptibility was measured with the aid of a magnetic balance at room temperature and at 370, 400 and 420°C. The measurements were taken at 10-15 minute intervals and in every case the value of relative magnetic susceptibility was determined, i.e. the force acting on the investigated specimen was compared with the force acting on a standard nickel sulphate specimen placed in an identical magnetic field. Electrical resistance was measured by the comparison of potential drop method, using a potentiometer and a sensitive galvanometer. In this case, both the solution treatment and ageing (at 370°C) were carried out in vacuum and the measurements were taken at 15 minute intervals. From the experimental data the average rate of ageing  $v_{cm}$  = the ratio of the maximum increment of the studied

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The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

property to the length of time required to effect this variation) was calculated for various investigated alloys and the results were reproduced graphically. Fig.1 shows how  $v_{cm}$  (assessed on the basis of hardness measurements) of alloys with a constant Sb content aged at  $370^{\circ}\text{C}$  varied with increasing Be content. The variation of  $v_{cm}$  (calculated from the data on magnetic susceptibility) of alloys containing 0.2% Sb and aged at  $370$ ,  $400$  and  $420^{\circ}$  with increasing Be content is shown in Fig.2, while Fig.3 shows the effect of Be on  $v_{cm}$  (determined on the basis of electrical resistance measurements) of the 0.2% Sb alloy aged at  $370^{\circ}\text{C}$ . The effect of the Sb and Be additions on the course of the ageing process in its various stages was determined on the basis of the measurements of magnetic susceptibility, since this property could be measured

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SOV/126-6-469/34

The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

with higher accuracy and without the necessity of interrupting the heat treatment. To this end, graphs showing the time-dependence of  $\Delta\chi$  were constructed,  $\Delta\chi$  being the difference between the values of the relative magnetic susceptibility of two alloys aged for a given period at 370°C: one with and the other without the addition(s), the effect of which was being examined. In this way the effect of Sb and Be (added separately) on the ageing process of the Cu-Ag alloy is shown on Fig.4. It can be seen that while antimony accelerates ageing at every stage of this process (this effect being most pronounced at  $t = 30$  min) the effect of beryllium is quite different: In the first stages of the ageing treatment this addition accelerates ageing, but beginning from a certain moment, it slows the process down. (The higher the Be content the earlier is the moment at which its delaying effect comes into operation

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SOV/126-64-9/34

The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of the Effects of small Alloying Additions on the Kinetics of Ageing of Alloys)

and the greater is the magnitude of the effect.)  
The effect of 0.2% Sb on ageing of Cu-Ag alloys containing 0.02 and 0.1% Be (Fig.5) is similar to its effect on the binary Cu-Ag alloy. The same applies to the effect of simultaneous additions of Sb and Be, except that in this case the maximum value of  $\Delta x$  decreases with increasing Be content (Fig.6). The effect of Be on kinetics of ageing of the Cu-Ag alloy containing 0.2% Sb is much more complex. At small concentrations (0.02%) beryllium accelerates ageing of the Cu-Ag-Sb alloy (graph 1) in all stages of the process,  $\Delta x$  reaching its maximum after 1 hr. 0.1% Be slows the process down in its initial stage and accelerates it slightly in the final stage. When present in larger quantities (0.2 - 0.3%) it slows down the ageing process of the Cu-Ag-Sb alloy at every

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The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

stage, its effect being most pronounced at  $t = 30$  min. The following interpretation of the obtained results is offered by the present authors: The average rate,  $v_{cm}$ , of the isothermal decomposition of a super-saturated solid solution of silver in copper is markedly affected by small simultaneously present additions of Sb and Be, even when these elements are present in concentrations considerably lower than their respective solid solubility limits. When added separately, antimony accelerates and beryllium slows down the process of decomposition. However, these effects are not additive when Sb and Be are present simultaneously: At a given Sb concentration  $v_{cm}$  increases at first with the increasing Be content, reaches a maximum and then slowly decreases (Fig.1-3). The higher the content of antimony the higher are the values of  $v_{cm}$  for any given beryllium concentrations

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The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

including those corresponding to the maximum values of  $v_{cm}$ . These effects can be explained on the basis of a hypothesis of internal adsorption of the Sb and Be atoms in structurally distorted zones linking the nuclei of decomposition with the solid solution matrix, it being postulated that the alloying elements can be adsorbed not only as separate atoms but also in the form of complexes containing atoms of both additions. As a result of the adsorption of complexes the free energy of the distorted zones is decreased in regions where - owing to the specific character of the distortion - it would not be decreased by adsorption of single atoms. The extent to which adsorption of complexes affects the kinetics of decomposition of the solid solution varies with time since, as a result of adsorption, the total concentration of both alloying elements in the adsorption zone is altered to a degree depending on the

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The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

overall concentration of the additions present simultaneously in the alloy: At a given Sb concentration, beryllium - when present in small quantities - is absorbed mainly in the form of complexes with the result that the concentration of Sb in the adsorption zone is increased and its accelerating effect on the decomposition of the solid solution is multiplied. On the other hand, when the Be content is high, it is adsorbed in the form of single atoms which increases its concentration in the adsorption zones with the result that the rate of decomposition is slowed down. The effects of Be and Sb on the course of the ageing process are also non-additive. In the initial stages of the process when formation of nuclei of decomposition is the predominant factor affecting the kinetics of decomposition, the effects of the alloying additions on nucleation due to local lattice distortions in the

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 The Effect of Small Additions of Antimony and Beryllium on Ageing  
 of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of  
 the Effects of Small Alloying Additions on the Kinetics of Ageing  
 of Alloys)

vicinity of the solute atoms are non-additive because  
 - owing to the fact that Be atoms are smaller and Sb  
 atoms larger than the solvent atoms - the lattice  
 distortions caused by the atoms of either element  
 present separately are more severe than those caused  
 by the complexes formed when the two alloying additions  
 are present simultaneously. In the later stages of the  
 ageing process when growth of the decomposition centres  
 affected by the adsorption of the alloying elements in  
 the surrounding zones is the predominating factor, the  
 non-additive character of the effects of Sb and Be is  
 evidently due to the fact that at first beryllium is  
 preferentially adsorbed, while adsorption of antimony  
 takes place mainly in the later stages. This time-lag  
 in the adsorption activities of the two elements is  
 probably associated with the fact that with the growth  
 of the decomposition nuclei the character and magnitude

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The Effect of Small Additions of Antimony and Beryllium on Ageing of the Copper-Silver Alloys. (Part IV. On the Problem of Causes of the Effects of Small Alloying Additions on the Kinetics of Ageing of Alloys)

of the lattice distortions in the zones connecting the nuclei with the solid solution matrix are correspondingly altered. There are 9 graphs, 1 table and 21 references of which 20 are Soviet and 1 English.

ASSOCIATION: Institut Fiziki Metallov Ural'skogo Filiala AN SSSR  
(Institute of Metal Physics, Ural Branch of the AS USSR)

SUBMITTED: 18th December 1956.

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SOV/126-6-5-6/43

AUTHORS: Arkharov, V.I. and Magat, L.M.

TITLE: The Effect of Small Amounts of Silver or Zinc Impurities on the Process of Ageing in Aluminium-Copper Alloys (O vliyanii malykh primesey serebra ili tsinka na protsess stareniya splavov alyuminiya s med'yu) (The Problem of the Causes of the Effect of Small Amounts of Impurities on the Kinetics of Ageing of Alloys. ) (K voprosu o prichinakh vliyaniya malykh primesey na kinetiku stareniya splavov. y)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 5, pp 804 - 808 (USSR)

ABSTRACT: This paper is part of a series; for previous work see Arkharov et al. (Ref 1). 31 aluminium-copper (0.5-4% Cu) alloys with small amounts of Ag (0.05-0.5%) and Zn (0.2-4%) were prepared. Their compositions are given in a table on p 805. Very pure materials were used to make the alloys. The components were melted in a carbon crucible at about 900 °C. Cast ingots were compression-deformed by 75%, annealed at 530 °C for 10-20 hours and quenched in water. Experiments were carried out on these alloys to determine the effect of Ag and Zn: (A) on ageing of aluminium-copper alloys

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The Effect of Small Amounts of Silver or Zinc Impurities on the Process of Ageing in Aluminium-Copper Alloys (The Problem of the Causes of the Effect of Small Amounts of Impurities on the Kinetics of Ageing of Alloys. V)

by finding the dependence of the lattice constants of the alloys on the duration of ageing (Figures 1, 2) and, (B) on solubility of copper in aluminium, by finding the dependence of the lattice constants of the Al-Cu alloys on the Cu content (Figure 3). The samples used in the (A) tests were hardened and aged at 245 °C and those used in the (B) tests were hardened, compression-deformed by 75%, annealed at 300 and 400 °C for 60 and 20 hours, respectively, hardened again and aged at 245 °C. A KROS-1 X-ray camera, with copper radiation ( $K_{\alpha_1}$  lines), was used to obtain the lattice constants<sup>to</sup> within  $\pm 0.0005$  kX units. The results are given in Figures 1-3. Figure 4 shows the Al corner of the Al-Cu-Zn phase diagram at 460 °C. The authors make the following conclusions from the results obtained. 1) Addition of Ag (0.05-0.5%) and Zn (0.2%) was found to have a weak decelerating effect on decomposition of the supersaturated solution of copper in aluminium during the initial hours

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SOV/126-6-5-6/43

The Effect of Small Amounts of Silver or Zinc Impurities on the Process of Ageing in Aluminium-Copper Alloys (The Problem of the Causes of the Effect of Small Amounts of Impurities on the Kinetics of Ageing of Alloys. V)

of ageing at 245 °C. 2) Introduction of Ag or Zn into the Al + 4% Cu alloy which is being aged increases solubility of Cu in Al. This increase of solubility is small when small amounts of Ag or Zn are added but it becomes considerable when larger amounts of the impurities are used. It follows, therefore, that the decelerating effect of Ag and Zn on ageing of the Al-Cu alloys cannot be explained by a change in the degree of supersaturation of the solid solution as a whole. 3) The decelerating effect of small amounts of Ag or Zn is ascribed to their internal adsorption on pre-transition formations in the supersaturated solid solution. Such an adsorption increases solubility of copper in the regions which are rich in Ag or Zn and slows down formation of nuclei of the new phase.

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SOV/126-6-5-6/43  
The Effect of Small Amounts of Silver or Zinc Impurities on the  
Process of Ageing in Aluminium-Copper Alloys (The Problem of the  
Causes of the Effect of Small Amounts of Impurities on the Kinetics  
of Ageing of Alloys. V)

There are 4 figures, 1 table and 7 references, 6 of which  
are Soviet and 1 English.

ASSOCIATIONS: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics of the Ural Branch of  
the Ac.Sc.USSR)  
Sverdlovskiy filial VNIIM (Sverdlovsk Branch  
of VNIIM)

SUBMITTED: February 26, 1958

Card 4/4

SOV/126-6-5-7/43

AUTHORS: Arkharov, V.I., and Magat, L.M.  
 TITLE: The Simultaneous Effect of Small Amounts of Cadmium and Silver or Zinc Impurities on the Process of Ageing of Aluminium-Copper Alloys (O sovmetnom vliyani malykh primesey kadmiya i serebra ili tsinka na protsess stareniya splavov alyuminiya s med'yu) (The Problem of the Causes of the Effect of Small Amounts of Impurities on the Kinetics of Ageing of Alloys. VI) (K voprosu o prichinakh vliyaniya malykh primesey na kinetiku stareniya splavov. VI)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 5, pp 809 - 811 (USSR)

ABSTRACT: For Part V, see the preceding paper (Ref 1). Eight aluminium-copper (4% Cu) alloys were prepared with small amounts of Cd (0.05%), Cd+Ag (together) (0.05-0.5% Ag) and Cd+Zn (0.5 - 1.0% Zn). The technique of preparation and testing of the samples was described by the authors in Part V (Ref 1). They studied the simultaneous effect of Cd+Ag or Cd+Zn on ageing of Al-Cu alloys at the stages when Cd accelerates, while Ag and Zn slow down decomposition of the supersaturated solid solution in these alloys. The effect of Cd, Ag and Zn was deduced

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SOV/126-6-5-7/43  
The Simultaneous Effect of Small Amounts of Cadmium and Silver or  
Zinc Impurities on the Process of Ageing of Aluminium-Copper Alloys  
(The Problem of the Causes of the Effect of Small Amounts of  
Impurities on the Kinetics of Ageing of Alloys)

from curves (Figures 1 and 2) showing the dependence of  
the lattice constant on the duration of ageing at 245 °C.  
It was found that 0.05% Cd accelerates ageing of the  
Al+4% Cu alloy at 245 °C (Figure 1, Curve 1). Addition  
of Ag to the Al+4%Cu+0.05%Cd alloy decreases the effect  
of Cd (Figure 1, Curves 2-5). The accelerating effect  
of Cd decreases with increase of the amount of Ag until  
at 0.5% Ag the effect of Cd is completely nullified,  
(Figure 1, Curve 5). It is suggested that the  
simultaneous action of Ag and Cd is due to internal  
adsorption of these two metals in aluminium-copper alloys.  
Addition of Zn to the Al+4%Cu+0.05%Cd alloy has only a  
very small effect on the rate of decomposition of the  
solid solution in the alloy (Figure 2).  
There are 2 figures, 1 table and 8 references, 4 of  
which are Soviet and 4 English.

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SOV/126-6-5-7/43

The Simultaneous Effect of Small Amounts of Cadmium and Silver or Zinc Impurities on the Process of Ageing of Aluminium-Copper Alloys (The Problem of the Causes of the Effect of Small Amounts of Impurities on the Kinetics of Ageing of Alloys)

ASSOCIATIONS: Institut fiziki metallov Ural'skogo filiala AN SSSR  
(Institute of Metal Physics of the Ural Branch of the Ac.Sc.USSR)  
Sverdlovskiy filial VNIIM (Sverdlovsk Branch of VNIIM)

SUBMITTED: February 26, 1958

Card 3/3

SOV/126-6-6-9/25

AUTHORS: Arkharov, V.I. and Bulychiev, D.K.

TITLE: On Changes in the Range of Stability of Wustite on the Diagram of State of the System Fe-O at Elevated Pressures (Ob izmenenii oblasti ustoychivosti vyustita na diagramme sostoyaniya sistemy Fe-O pri povyshenii davleniya)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 6, pp 1027 - 1030 (USSR)

ABSTRACT: In earlier work (Ref 1) the authors established that, under the effect of high pressures, wustite will decompose in the temperature range 500 to 450 °C, whilst in other earlier work (Ref 2) the authors established that wustite will form as a component of the scale during oxidation of iron in the same temperature range at more elevated pressures. To explain this apparent contradiction, the authors have expressed the opinion that, to some extent, the pressure shifts the boundary of the range of homogeneity of wustite in the diagram of state of the system Fe-O. According to this assumption, the point which represents the lower temperature boundary of the stability range of wustite shifts downwards and towards higher oxygen contents. Thereby, the lower temperature boundary of the

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SOV/126-6-6-9/25

On Changes in the Range of Stability of Wustite on the Diagram of State of the System Fe-O at Elevated Pressures

wustite of the composition referred to in the earlier work (Ref 1) will shift only slightly under the effect of high pressures; in the temperature range 500 - 450 °C the wustite will prove unstable and will decompose. However, during oxidation of iron under a high pressure in the temperature range 500 - 450 °C wustite can form but it will be appropriately enriched with oxygen. To verify the correctness of this assumption, it was necessary to determine the lattice parameters of the wustite which formed during oxidation of iron at an elevated pressure and to compare the measured values with those obtained for the case of oxidation of iron at normal pressure above the lower temperature boundary of the stability range of wustite. In both cases which are compared it is necessary to have an equal degree of oxidation (an equal specific weight increase of the specimens) which is attained by appropriately selecting the duration of the oxidation. In this paper, the results are described of such experiments which were carried out for the purpose of verifying the

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SOV/126-6-6-9/25

On Changes in the Range of Stability of Wustite on the Diagram of State of the System Fe-O at Elevated Pressures

here expressed hypothesis. The following two oxidation variants were chosen: heating for 60 min at 650 °C under normal pressure; heating at 500 °C for 30 min at a pressure of 100 atm. In both cases, the same furnace was used. In all cases, the cooling of the specimens after the experiments took 10-15 min. The weight increase of the specimens amounted to 5.8 mg/cm<sup>2</sup> for the first mentioned variant and 6.3 mg/cm<sup>2</sup> for the second mentioned variant. According to X-ray data, the scale contained in both cases wustite in addition to haematite and magnetite. The authors were also interested in finding out to what extent the experimentally determined lattice parameters of the wustite were in agreement with the earlier expressed hypothesis on the influence of the high pressure on the range of stability of wustite on the diagram of state Fe-O. It is stated that the obtained result is in agreement with the hypothesis expressed by the authors in their earlier work (Ref 2) and that this can be considered as a rough quantitative confirmation of that

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SOV/126-6-6-9/25

On Changes in the Range of Stability of Wustite on the Diagram of State of the System Fe-O at Elevated Pressures

hypothesis. It also forms the basis for further experiments aimed at obtaining more accurate information on the assumed displacement of the boundaries of wustite on the diagram of state. There are 1 figure and 7 references, 5 of which are Soviet, 1 French and 1 English.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of  
: Metal Physics of the Ac.Sc.USSR)

SUBMITTED: July 25, 1958

Card 4/4

ARKHAROV, V.I.

Research on the heat resistance of alloys at the Physics of  
Metals Institute of the Academy of Sciences of the U.S.S.R.  
Ural Branch. Trudy Inst.fiz.met.UFAN SSSR no.19:3-6 '58.  
(MIRA 12:2)

(Metallurgical research) (Heat-resistant alloys)

ARKHAROV, V.I.; YAKUTOVICH, M.V.

Heat resistance and internal adsorption in polycrystalline  
alloys. Trudy Inst.fiz.met.UFAN SSSR no.19:7-22 '58.  
(MIRA 12:2)  
(Heat-resistant alloys) (Adsorption) (Metal crystals)



ARKHAROV, V.I.; IVANOVSKAYA, S.I.; POLIKARPOVA, I.P.; CHUPRAKOVA, N.P.

Investigating nonuniformity in interstitial diffusion of nickel  
in polycrystalline iron-chromium-nickel alloys. Trudy Inst.fiz.  
met.UFAN SSSR no.19:23-42 '58. (MIRA 12:2)  
(Diffusion) (Iron-chromium-nickel alloys)

ARKHAROV, V.I.; PEN'TINA, A.A.

Effect of internal adsorption on changes in heat-resistant alloy crystal lattice parameters with changes of the crystal-lite size. Trudy Inst.fiz.met.UFAN SSSR no.19:43-47 '58.

(MIRA 12:2)

(Adsorption) (Crystal lattices) (Heat-resistant alloys)

ARKHAROV, V.I.; IVANOVSKAYA, S.I.; KOLESHNIKOV, G.N.; MOISEYEV, A.I.

Stress relaxation and nonuniformity of diffusion mobility in  
polycrystalline austenitic iron-chromium-nickel alloys. Trudy  
Inst.fiz.met.UFAN SSSR no.19:122-126 '58. (MIRA 12:2)  
(Diffusion) (Iron-chromium-nickel alloys) (Deformations (Mechanics))

ARKHAROV, V.I.

Effect of internal adsorption on the aging processes in alloys  
and the probable significance of this effect for heat resistance.  
Trudy Inst.fiz.met.UFAN SSSR no.19:153-162 '58. (MIRA 12:2)  
(Heat-resistant alloys) (Adsorption)

ARCHAROV, V.I.

Internal Adsorption in solid solutions. Trudy Inst.fiz.net. UPAN SSSR  
no.20:201-228 '58.  
(Solutions, Solid) (Adsorption) (MIRA 12:11)

18.8300  
18.7500

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Translation from: Referativnyy zhurnal. Khimiya, 1959, Nr 8, pp 322 - 323 (USSR)

SOV/81-59-8-27794

AUTHOR: Arkharov, V.I.

TITLE: The Reflection of the Physical Mechanism of Reaction Diffusion in the Structural Picture of Reaction Product Layers (The Physical Foundations of the Gas Corrosion Process of Metals and Alloys)

PERIODICAL: Tr. In-ta fiz. metallov. Ural'skiy fil. AS USSR, 1958, Nr 20, pp 229-243

ABSTRACT: The diversity of factors is noted which act on reaction diffusion (RD), to the number of which belong the numerous crystallochemical factors caused by the nature and the structural peculiarities of the contiguous solid phases, as well as by the volume changes accompanying the phase re-arrangement on the boundary between the solid phases (under RD the chemical interaction of 2 media is understood, which proceeds through the layers of the reaction products appearing on their primary boundary of their contact). A consequence of the re-arrangement between the solid phases is the appearance of inner stresses and phase self-hardening in the crystal lattice. Additional complications are introduced into the RD process by an increase in the number of components of both the metal phase (alloying additions)

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SOV/81-59-8-27794

The Reflection of the Physical Mechanism of Reaction Diffusion in the Structural Picture of Reaction Product Layers. (The Physical Foundations of the Gas Corrosion Process of Metals and Alloys)

and the gaseous phase. The course of the RD process is predetermined by the structure of the scale (if the oxidation of the metals and the alloys is considered). This fact is the foundation for the method of studying the mechanism of the oxidation from the data of the scale structure, to the number of which the author refers the microstructure, the phase composition of various scale layers, the size and the form of the crystals, etc. Moreover, a review of the research on the study of the structural mechanism of RD is cited. An important role is played in this case by the establishment of the fine structures in the layers of RD products, which in the same chemical composition of the phase permit the elucidation of small differences in the distribution of vacant points and the location of atoms in interstices. As an example of the effect of the fine structure the mechanism of the loss of the heat resistance of Fe within the range of 600 - 800°C is considered, as well as the sharp increase in the rate of scale formation at >800°C. According to the results of the study of the scale structure the conclusion is drawn that the speed-up course of oxidation at increased temperatures is caused by an increase in the diffusion rate of Fe-ions through the scale outwards. The cause of the increased diffusion rate of Fe-ions the author explains by the intrusion of O-atoms into

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SOV/81-59-8-27794

The Reflection of the Physical Mechanism of Reaction Diffusion in the Structural Picture of Reaction Product Layers. (The Physical Foundations of the Gas Corrosion Process of Metals and Alloys)

the hematite lattice and its loosening. The complex  $\text{Fe}_2\text{O}_3$  lattice is a great obstacle for the diffusion of Fe-ions, and in this connection the mechanism of the effect of additions increasing the heat-resistance can be understood as a result of the strengthening of the bond forces in the  $\text{Fe}_2\text{O}_3$  lattice.

A. Shatalov

Card 3/3



SOV/58-59-5-10662

Translation from: Referativnyy Zhurnal Fizika, 1959, Nr 5, p 114 (USSR)

AUTHOR: Arkharov, V.I.

TITLE: Internal Adsorption in Solid Solutions (Non-Uniform Concentration  
Distribution in Solids due to Structural Inhomogeneities)

PERIODICAL: Tr. In-ta fiz. metallov, Ural'skiy fil. AS USSR, 1958, Vol 24, Nr 10,  
pp 201 - 228

ABSTRACT: The article has not been reviewed.

Card 1/1

ARAHAROV, V.

504/73355

## UNIVERSITY BOOK EXPLOITATION

18(7)  
 Kuchumov, A. V.  
 Problemy metallurgii.  
 Institut metallurgii.  
 Nauchnyy sovets po  
 metallurgii.  
 Moscow, 1959. 400 p.  
 200 copies printed.

probleme sharoprochnyykh splavov  
Inzhenerov po sharoprochnym splavam, t. IV (Studies on  
Assistant Alloy, vol. 4), Moscow, Izd-vo AN SSSR, 1999. 400 p.  
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Ed. of Publishing House: V. A. Elisor; Tech. Ed.: A. P. Guseva;  
Editorial Board: I. P. Bardin, Academician; O. V. Kurdyumov,  
Academician; N. V. Agayev; Corresponding Member, USSR Academy of  
Sciences; I. A. Oging, I. M. Pavlov, and I. P. Zudin, Candidates  
of Technical Sciences.

**PURPOSE:** This book is intended for metallurgists concerned with the structural metallurgy of alloys.

**COVERAGE:** This is a collection of specialized studies of various problems in the structural metallurgy of heat-resistant alloys. Some are aimed with theoretical principles, some with descriptions of new equipment and methods. Various phenomena occurring under specified conditions are also treated. The articles are accompanied by a number of illustrations. The articles are accompanied by a number of illustrations. The articles are accompanied by a number of illustrations.

## 82-104102 (cont.)

50V/3355

Studies (cont.)  
50V/1555

Investigation of the Diffusion of Cobalt and Iron Along  
the Grain Boundaries  
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B. N. Koshlitskiy  
Effect of Stress and Strain on the Dif-  
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Effect of Small Impurities on the Coefficient of Dif-  
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Effect of Heat Treatment on the Properties of  
Fusion in Polycrystalline Materials

Arbuzov, V. I., M. M. Belenkova, M. N. Mikhovskiy,  
Kuznetsov, I. S., and E. P. Polycarpova. Concerning Changes  
in the Effect of Various Additives at Different Stages  
of Aging of Alloys

### of Aging of Alloys

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ARKHAROV, V. I.

18(7)

FRASE I BOOK EXPLOITATION

SOV/3355

Akademiya nauk SSSR. Institut metallurgii. Nauchnyy sovet po  
probleme zharnoprochnykh splavov  
Iskovedeniya po zharnoprochnym splavam, t. IV (Studies on Heat-  
Resistant Alloys, vol. 4). Moscow, Izd-vo AN SSSR, 1959. 400 p.  
Kratka elip inserted. 2,200 copies printed.

Ed. of Publishing House: V. A. Klimov; Tech. Ed.: A. P. Guseva;  
Editorial Board: I. P. Bardin, Academician; G. V. Kurdymov,  
Academician; N. V. Agayev; Corresponding Member, USSR Academy of  
Sciences; I. A. Odling, I. M. Pavlov, and I. P. Zudin, Candidate  
of Technical Sciences.

PURPOSE: This book is intended for metallurgists concerned with  
the structural metallurgy of alloys.

CONTENTS: This is a collection of specialized studies of various problems in  
the structural metallurgy of heat-resistant alloys. Some are concerned with  
theoretical principles, some with descriptions of new equipment and methods,  
others with properties of specific materials. Various details, occurring under  
specified conditions are studied and reported on. For details, see Table of  
Contents. The articles are accompanied by a number of references, both Soviet  
and non-Soviet.

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Arkharov, V. I., and B. S. Borzantsev. Effect of Alloying Elements on the Scale Resistance of Alloys and on Bond Strength in Oxide-Phase Interfaces in Scale. Effect of Nickel and the Combined Effect of Chromium and Nickel on the Bond Strength in Heat-treatable	340

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ARKHAROV, V. I.

18(0)	PLANS I BOOK EXPLOITATION 507/2516
	Admiralty main USSR. Institut naukovy i tekhnicheskoy informatsii
	Metallurgiya SSSR, 1977-1978; [n.] II (Metallurgy in the USSR, 1977-1978; Vol. 2)
	Moscow, Metallurgizdat, 1979. 813 p. Kuznetsov inserted, 5,000 copies printed.
	MA. (Title page); I. P. Bartin, Academician; MA. (Inside book); G. V. Popov; Tech. Ed.: P. O. Izrael's yem.
	PURPOSE: This book is intended for metallurgists.
	COVERAGE: The articles in this collection present historical data on the achievements of Soviet metallurgy, both scientific and technical, during the period 1917-1977. Advances in theory and practice in the application of individual branches of metallurgy and give an idea of the present status expected in the future. Advances made in other countries are also discussed. The articles are accompanied by a large number of references. For further coverage, see Table of Contents.
	Plakhotnikov, Candidate of Technical Sciences; and A. G. Filimonov, Candidate of Technical Sciences. (Institute of Metallurgy Lenin A. A. Maykov, USSR Academy of Sciences) Achievements in Railroad Wheel and Tire Production 101
	Changes in engineering specifications and improvements in production techniques and quality of tires and solid wheels in the USSR since 1940 are discussed. Further progress in this field is predicted.
	Zinin, A. I., Professor, Doctor of Technical Sciences. (VNIPI) Forging and Stamping Methods 113
	This is a historical survey of developments in forging and stamping processes in Russia from pre-revolutionary times up to 1977.
	Levi, I. I., Candidate of Technical Sciences. (Moscow Institute of Machine Design) Production of Castings 141
	The paper traces the general course of development and discusses problems in the theory of casting, casting alloys, basic melting processes, molding and core sand, non-metallic solids, special casting methods (permanent mold casting, die casting, continuous casting, centrifugal casting, investment casting, etc.), equipment, mechanization, and automation.
	Mal'tshin, M. Yu., Candidate of Technical Sciences; and G. V. Smolov, Candidate of Technical Sciences. (Institute of Metallurgy Lenin A. A. Maykov, USSR Academy of Sciences; and Institute of Powder Metallurgy, Ukrainian Academy of Sciences) Powder Metallurgy 175
	The article is a general survey of the development and present state of powder metallurgy in the USSR. Theoretical and practical aspects of the preparation of sintered and sintered metal products are discussed.
	Rybalin, E. K., Corresponding Member, USSR Academy of Sciences; E. O. Ocheretnikov, Professor, Doctor of Technical Sciences; A. A. Yermolov, Candidate of Technical Sciences; and V. Kh. Shorshorov, Candidate of Technical Sciences. (Institute of Metallurgy Lenin A. A. Maykov, USSR Academy of Sciences; and Leningrad Polytechnic Institute) Progress in the Science of Welding Metals in the USSR 194
	The authors discuss the studies that have been made in the USSR of the theoretical aspects of welding, beginning in the latter part of the nineteenth century. Specific topics are: investigation of the arc, Card 5/25

ARKHAROV, V.I.; KLOTSMAN, S.M.; TIMOFEYEV, A.N.

Effect of small additions on diffusivity in polycrystalline  
materials. Issl.po zharopr.splav. 4:170-175 '59.

(MIRA 13:5)

(Diffusion) (Metals at high temperature)

ARKHAROV, V.I.; BELENKOVA, M.M.; MIKHEYEV, M.N.; MOISEYEV, A.I.;  
POLIKARPOVA, I.P.

Changes in the effectiveness of various additions at the various  
stages of the aging of alloys. Issl.po sharopr.splav. 4:  
176-180 '59. (MIRA 13:5)  
(Solutions, Solid--Analysis)

ARKHAROV, V.I.; BORISOV, B.S.

Effect of alloying elements on the heat resistance of alloys  
and binding forces in oxide phase lattices of scale. Effect of  
nickel and the combined effect of chromium and nickel on binding  
forces in hematite. Issl.po zharopr.splav. 4:340-342 '59.  
(MIRA 13:5)

(Heat-resistant alloys--Corrosion)

(Hematite--Metallography)

SOV/126-7-1-9/28

AUTHORS: Arkharov, V.I., Konev, V.N. and Men'shikov, A.Z.

TITLE: Investigation of Diffusion in the System Chromium-Nitrogen  
(Issledovaniye diffuzii v sisteme khrom-azot)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1959, Vol 7, Nr 1,  
pp 64-71 (USSR)

ABSTRACT: Nitrogen participates in the diffusion of oxygen or carbon in chromium at high temperatures. In the present work nitriding of chromium in an atmosphere of ammonia was studied. The kinetics of the process, phase composition, texture and microstructure of the nitride layers was studied during their formation at various temperatures between 600 and 1200°C. Electrolytic chromium served as the basic material in the study. Specimens were made by Arkharov's method (Ref.14) in the shape of hollow cylinders, 17 mm long, 7 mm diameter and 0.8 mm wall thickness. Deposition was carried out by two different methods, giving two different types of coating (Ref.15) - (1) bright chromium deposits, having a well-defined texture, and (2) matt (grey) deposits  
Card 1/5 with a weakly defined texture. Nitriding was carried out



SOV/126-7-1-9/28

## Investigation of Diffusion in the System Chromium-Nitrogen

in a closed vertical quartz tube placed inside a tubular electric furnace. Before and after nitriding the specimens were weighed and the increase in weight determined. Debye crystallograms of the phase analysis were taken in K-Cr rays after asymmetrically blocking up the film. Textural X-ray pictures were taken and interpreted by a method described by Arkharov (Ref.16). For the metallographic study chromium deposits were prepared on steel cylinders on which flat portions had been filed along the generatrix. After nitriding, oblique sections of these flat portions were prepared for micro-examination. In Fig.1 the dependence of weight gains of specimens at various temperatures on duration of nitriding is shown. Fig.2 shows the temperature dependence of the angle of inclination of the kinetic curves for nitriding of chromium. In Fig.3 a micrographic cross-section of a chromium specimen after being nitrided right through is shown. Fig.4 shows the dependence of gain in weight of specimens of  $\text{Cr}_2\text{N}$  on the length of nitriding time.

Fig.5 shows the temperature dependence of the angle of inclination of the kinetic curves for nitriding of  $\text{Cr}_2\text{N}$ .

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SOV/126-7-1-9/28

Investigation of Diffusion in the System Chromium-Nitrogen

The results obtained in the above investigation have led to the following conclusions:

- (1) The reaction diffusion in the system Cr-N begins with perceptible speed at  $700^{\circ}\text{C}$  and obeys the parabolic time law in the entire temperature range up to  $1200^{\circ}\text{C}$ .
- (2) As the temperature is increased, the diffusion rate of the Cr-N increases initially slowly (i.e. below  $1030^{\circ}\text{C}$ ), then rapidly (above  $1030^{\circ}\text{C}$ ).
- (3) Below  $1030^{\circ}\text{C}$  nitriding produces a two-phase layer in chromium - an internal, thicker one of  $\text{Cr}_2\text{N}$  and an outer, thinner one of CrN. Above  $1030^{\circ}\text{C}$  only the  $\text{Cr}_2\text{N}$  layer is formed. The CrN phase is unstable in an ammonia atmosphere above  $1030^{\circ}\text{C}$ . It does not re-form and the phase CrN, forming below  $1030^{\circ}\text{C}$ , is converted into the phase  $\text{Cr}_2\text{N}$  as this temperature is raised. The change in increase in the diffusion rate with temperature at above  $1030^{\circ}\text{C}$  seems to be associated with a change in the nature of the phase in the diffusion layers.
- (4) As the  $\text{Cr}_2\text{N}$  layer forms in textured chromium the texture of the type

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SOV/126-7-1-9/28

# Investigation of Diffusion in the System Chromium-Nitrogen

$(110) \text{Cr}_2\text{N} \parallel (111) \text{Cr} \parallel \text{NP}$

or possibly

$(120) \text{Cr}_2\text{N} \parallel (111) \text{Cr} \parallel \text{NP}$

forms at all temperatures. In untextured chromium the  $\text{Cr}_2\text{N}$  possesses no texture.

(5) The outer layer,  $\text{CrN}$  (forming at below  $1030^\circ\text{C}$ ) never possesses a texture, irrespective of whether the chromium and the  $\text{Cr}_2\text{N}$  layer have a texture or not.

(6) All structural characteristics of the layers point to the fact that during reaction diffusion in the Cr-N system nitrogen diffuses from without through the nitride layer into the metal, and no perceptible diffusion of the metal occurs in the reverse direction.

There are 5 figures, 2 tables and 18 references, of which

Card 4/5 8 are Soviet, 4 German, 1 French, 1 Swedish and 4 English.

SOV/126-7-1-9/28

Investigation of Diffusion in the System Chromium-Nitrogen

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A.M. Gor'kogo  
(Ural State University imeni A.M. Gor'kiy)

SUBMITTED: March 3, 1958

Card 5/5

24(6), 24(2)

AUTHOR: Arkharov, V. I.

SOV/126-7-2-8/39

TITLE: On the Effect of Complexity of an "Elementary Act" on the Temperature Dependence of the Rate of the Atomic-Kinetic Process in the Solid State and on the Magnitude of the Apparent Activation Energy (O vliyanii slozhnosti "elementarnogo akta" na temperaturnuyu zavisimost' skorosti atomno-kineticheskogo protsessa v tverdoy faze i na velichinu kazhushcheysya energii aktivatsii)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1969, Vol 7, Nr 2, pp 209-213 (USSR)

ABSTRACT: The author discusses an "elementary act" of structural change in a crystal, consisting of a displacement of one atom from its site to a neighbouring site. He shows that the rate of the atomic-kinetic processes in solids, consisting of elementary acts, is given by:

$$K' = K'_0 \exp (-Q/RT),$$

where  $Q$  is the activation energy of an elementary act in a non-disturbed lattice and  $K'_0$  is a function of temperature  $T$ . Since temperature enters the pre-exponential factor,

Card 1/2 the usual method of determination of  $Q$  from the slope of

SOV/126-7-2-8/39

On the Effect of Complexity of an "Elementary Act" on the Temperature Dependence of the Rate of the Atomic-Kinetic Process in the Solid State and on the Magnitude of the Apparent Activation Energy

$\log K' = f(1/T)$  gives only an apparent value,  $Q_a$ , of the activation energy, which may differ considerably from the true value  $Q$ . The situation is further complicated by the possibility of an atom being displaced by more than one interatomic distance or by several atoms being displaced simultaneously. Such complex elementary acts may occur in plastic processes, bainite transformation in steel, rapid recrystallization, etc. The complexity of the elementary act affects the rate equation of the atomic-kinetic processes, making the pre-exponential factor even more involved. The apparent activation energy  $Q_a$  of two complex elementary acts may be compared only when these acts are the same; otherwise such comparisons lose their physical sense. There is 1 Soviet reference.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, Ac.Sc., USSR)

SUBMITTED: June 9, 1958

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SOV/126-7-3-30/44  
AUTHORS: Arkharov, V. I., Vangengeym, S. D. and Klyuyeva, I. B.  
TITLE: X-Ray Investigation<sup>1</sup> of Intercrystalline Internal Adsorption  
in Copper Base Alloys<sup>2</sup> (Rentgenograficheskoye issledovaniye  
mezhkristallitnoy vnutrenney adsorbtsii v splavakh na osnove  
medi)

PERIODICAL: Fizika metallov i metallovedeniye, Vol 7, Nr 3, pp 457-  
458 (USSR)

ABSTRACT: Reversible changes in the lattice parameter<sup>1</sup> with change in grain size of polycrystalline solid solutions have been observed by Arkharov et alia (Refs.1, 2) in a series of binary and ternary alloys. These changes can be explained on the basis of an earlier hypothesis proposed by Arkharov (Ref.3) of the intercrystalline internal adsorption. In the present work the effect of reversible lattice parameter change has been observed in the alloy systems Cu-Ag,<sup>2</sup> Cu-Mg<sup>2</sup> and Cu-Sn.<sup>2</sup> The systems were chosen so that the addition elements should have a different valency. Alloys with horophile (positively active relative to internal adsorption) addition contents of the order of 1 - 2% were melted in a

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Base Alloys

high frequency induction furnace. The ingots were homogenized, and after forging and supplementary annealing were cut into separate specimens. The latter were transformed by thermomechanical treatment, into either the fine-grained or coarse-grained state. In order to obtain a fine grain size (of the order of 0.05 mm) the specimens were thoroughly forged and annealed in a temperature range of 550 - 600°C; in order to ensure a coarse grain size they were reduced in a press by 5 - 10% and annealed at 800 - 900°C. After each annealing a layer, 1 mm thick, was removed from the specimens by means of concentrated nitric acid. The grain size was determined metallographically after etching in a solution of ammonium persulphate and ammonia. An X-ray investigation of the lattice parameter of the solid solutions was carried out by the Zaks method in a KROS-1 camera, using Co-irradiation. The results of the X-ray investigation are compiled in the table on p 458.

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There is 1 table, and 3 Soviet references.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet imeni A. M. Gor'kogo  
(Ural State University imeni A. M. Gor'kiy)

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SOV/126-7-3-41/44

AUTHORS: Arkharov, V. I., Vangengeym, S. D. and Klyuyeva, I. B.

TITLE: On the Causes of Brittleness<sup>16</sup> of Certain Copper Alloys<sup>21</sup>  
(K voprosu o prichinakh khrupkosti nekotorykh mednykh splavov)

PERIODICAL: Fizika metallov i metallovedeniye, Vol 7, Nr 3, pp 476-477  
(USSR)

ABSTRACT: Data exist of the fact that additions of Sb<sup>17</sup> (of the order of a few tenths of %) to Cu lead to a steep decrease in the impact resistance of the alloy (Refs.4 and 5). In this connection McLean (Ref.4) has established a hypothesis which coincides in its content with that pronounced earlier by Arkharov (Ref.1), and according to which the brittleness of copper containing antimony must be due to a "segregation without precipitation from the solid solution" of antimony atoms in the intercrystalline boundary region. In such a case, by bringing about preferential internal adsorption of Be in the intercrystalline zones, a complete (or nearly complete) displacement of Sb from these zones can be brought about, resulting in a rise of the impact resistance of an alloy with the same antimony content. The aim of

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the present work was to confirm this assumption. The following alloys were selected for study: (1) Cu + 1% Sb + 0.2% Be; (2) Cu + 1% Sb + 0.6% Be; (3) Cu + 1% Sb + 1% Be. The purity of the original copper was 99.99%. Ingots (melted under a borax layer in a graphite crucible) were forged into rods of square cross-section and given a homogenizing anneal (900°C, 35 hours). From these forgings specimens for impact testing were made (bars, 60 x 10 x 10 mm, with a hemispherical notch in the central line, 1 mm deep). From the remaining portion of the forgings specimens for X-ray investigation were made. X-ray investigation results have shown that preferential internal adsorption of Sb occurs in the first series of alloys; in the second and third series beryllium is preferentially internally adsorbed. Specimens for impact testing were annealed in an iron container which was covered with carbon, at 600°C for 20 hours. One half of the specimens of each series were quenched in water, the other half were slowly furnace cooled. The tests were carried out on a 30 kg pendulum impact machine. The second (reference) batch of specimens in contrast to the first were melted in evacuated and sealed quartz ampoules ( $10^{-4}$  -  $10^{-6}$  mm Hg). The dimensions of these specimens were 40 x 5 x 5 mm.

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Their composition was chosen so as to decrease the concentration of beryllium to the greatest extent without changing the conditions for its preferential internal adsorption. In alloys containing Cu + 0.2% Sb + 0.2% Be, and those containing Cu + 0.5% Sb + 0.2% Be preferential internal adsorption of Be occurred; in alloys containing Cu + 1% Sb + 0.2% Be preferential internal adsorption of Sb occurred. The results of impact tests of specimens of the first and second batch have shown that the impact resistance in slowly cooled specimens did not change greatly with changing composition; in quenched specimens in the same cases, however, when antimony was preferentially adsorbed at the intercrystalline boundaries, the impact resistance was greatly lowered as compared with that of the specimens at which Beryllium was preferentially internally adsorbed. Thus it can be seen that the harmful influence of antimony on the impact resistance of copper can be diminished.

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There are 6 references, of which 4 are Soviet and 2 English.

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